

Building the Engineer – Not Just the Structure

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Abstract:

From inception, in 2010, ConStructEd Scotland has taken students studying within the built environment faculty and in particular civil and structural engineering students and looked to turn their theory into practice through an on-site experience where they are tasked with delivering a live construction project safely, on schedule and within their own budget.

This paper will look at how these early principles have been developed over the past six years, and further developed during times of Covid, to focus much more on the individual journey that each student takes during the five day intensive study period. where their softer skills are challenged and honed ensuring that participating students can align their personal development against the ICE's 7 Professional Attributes.

By taking the data obtained during our three years involvement in University of Strathclyde CL995: Industrial Design and Construction Masters Program where the participating students were taken out of their comfort zone and how immersing them in this multi-cultural learning environment with a mix of secondary, college and university students it was possible to challenge Masters students' emotional intelligence within a safe environment whilst creating an experience like no other that offered a richer learning experience with context.

Keywords; symposium, engineering education, transformation, unsustainable, society, international.

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1. INTRODUCTION

ExpLearn Limited has been delivering experiential learning activities across Europe for the past 6 years working with multinational students across a wide range of faculties whilst developing and driving the operational side of ConStructEd Scotland, formerly known as Constructionarium Scotland, a provider of real on-site experience to undergraduate civil and structural engineers and other undergraduates studying within the Built Environment disciplines. The participating students are able to turn their theory into practice during a five day intensive study period where they are challenged to deliver a representation of an iconic or conceptual structure from two dimensional drawings. During the immersive learning activity participants are allowed to learn by doing through the formation of their own company in which they take up 'functional roles', self-allocate and establish their own hierarchical management system to ensure the safe, timely and budgeted delivery of their project. The Joint Board of Moderators, in their annual reporting consistently

highlights involvement in this program as an example of good practice [p.23 Report on JBM Activities in 2013 and 2014]

2. THE JOURNEY, NOT THE STRUCTURE

Since early 2015 the Institute of Civil Engineers has introduced its new Initial Professional Development which would use their ICE Attributes system to measure new trainees at all stages up until and including the Professional Review. ‘We can easily define the Attributes as the core pillars for your development towards being professionally qualified. [Civil Engineering Exam <https://thecivilengineeringexam.com/ice-attributes-introduction/>]

1. Understanding and Practical Application of Engineering
2. Management and Leadership
3. Commercial Ability
4. Health, Safety and Welfare
5. Sustainable Development
6. Interpersonal Skills and Communication
7. Professional Commitment

The seven attributes and subsequent sub attributes were updated and brought in from 2021 allowing a clearly defined pathway to becoming professionally qualified. When participating in the ConStructEd program all seven of these key Attributes are challenged and developed in equal measure and become more important as the pedagogy of the program than the completion of the end structure, although it is this end structure for the student that remains the focus of their labours and drives them to completion. It is also worthy to note when we are looking at ‘the journey’ relating to the intensive study period this is a very personal one. In as much as they are all working together in building the same end structure each of them will have their own personal experience which will depend on how emersed that they have allowed themselves to become within the learning experience. They could in effect become solely a ‘passenger’ in which they deviate minimally from the experience of the implementation of their technical knowledge but on reflection back on their experience we find that commonly they have had a much deeper learning experience in which their transversal skills have been enhanced through the wider site experience which again aligns itself with the Attributes 2, 4 and 6 which are often the more difficult of the Attributes to qualify. By participating in the ConStructEd project week it is possible to show a personal development in all 7 of the ICE Key Attributes.

3. CL995: INDUSTRIAL DESIGN AND CONSTRUCTION, MASTER PROGRAM

In 2019, ExpLearn collaborated with University of Strathclyde developing an onsite experience for the subsequent final three years of the master program CL995: Industrial Design and Construction where the participating students were given an early brief to develop a concept design for a structure which could be as proposed without constraint of cost or buildability. These would be peer to peer reviewed to create a short list of projects that would then be developed to an engineered solution over a period of some eight weeks with a mixture of technical and softer skills presentations from industry experts before a design was finally agreed upon as the one that would be moved to construction. A representation of this proposal was then developed into a live project

by consulting engineering practice for the Master students to construct over a five day intensive study period on the ConStructEd facility at Armadale, West Lothian, Scotland. The Masters students formed the senior management team of the ‘Company’ with other undergraduates, college students and senior phase secondary school pupils volunteering to work as part of the construction company over the five-day period.

Each year had a different brief: year one was a viewing platform to be situated next to the new Rothera Wharf, in the Antarctic and this was supported by BAM Nuttall, SwecoUK and Kiloh Associates; year two was a new footpath over the River Clyde at a specific location and this was supported by BAM Nuttall and Jacobs; whilst the third year was a replacement Clyde Tunnel and supported by BAM Nuttall and Curtins Consulting. This collaboration is currently shortlisted for a European Triple E Awards, Triple Helix Collaboration of the Year Award

4. THE SOFTER SKILLS: TRANSVERSAL SKILLS FOR EMPLOYABILITY

Professor James Plumber, former Dean of the School of Engineering at Stanford advocated in 2017 to broaden engineer education to include more liberal arts exposure and more life skills with the aim of preparing future engineers for unpredictable careers.

“Engineers will need communication skills, the ability to work in teams, global knowledge, and an entrepreneurial look as much as they will need technical depth for the future”

These principles of the so called “soft skills” , mentioned by the distinguished former Dean still resonate nowadays regarding well rounded engineers. Strathclyde University applies these principles in its ICE seven attributes; part of the Professional Development four-year plan in the Civil Engineering Exam to become professionally qualified.

In 2020 The Masters programme **CL995: Industrial Design and Construction** students were exposed to a training on Emotional intelligence Employability by Drs. J. Huisman, experienced Dutch researcher and trainer on Emotional Intelligence, Empathy and Intercultural Communication. The training/intervention was aimed at enhancing students’ awareness on these particular skills; aligned with ICE attributes 2 “ Management and Leadership” and 6 “Interpersonal Skills and Communication” . The training/Interventions consisted of a workshop to familiarise students with the term Emotional Intelligence and what it entails, to be followed by a questionnaire on empathy in order to establish the initial stadium in which students were before embarking in their intensive study period. After the intensive period students were presented with another questionnaire with similar questions related to Emotional Intelligence and Empathy to monitor any change in answers in comparison with the ones given prior to the intensive study period. All respondents filled out the questionnaires voluntarily and anonymously, which aligns with data protection regulations when gathering data for academic purposes. A future step will be to follow up these students in their professional life the coming and measure the impact of the exposure to the training had in their professional development.

The questionnaires and subsequent matrix were manufactured by Drs. J. Huisman according to the American psychologist Dr. D. Goleman (2019) principles, who describes Emotional or Social Intelligence as “ the ability to manage one’s feeling so that those feelings are expressed appropriately and effectively”. D.Goleman states that emotional intelligence is the largest single predictor of success in the workplace. His theory outlines five components of EQ; **Self-awareness, self-regulation, motivation, empathy, and social skills.**

The initial questionnaire showed most of the students scored well in self-awareness, and self-regulation. However, their responses were based on a traditional model of leadership and control regarding leadership. This model did not work well during the intensive period, the working teams were compounded by multiple nationalities, local included, and different layers of education, which lead to different perspectives on what leadership should be. The majority of the Master students, namely 97 %, realised during the intensive period that their leadership style had an impact on the effectiveness of the teams they were leading. In their final reflection many of them stated that they needed to further develop their leadership skills towards a more emotionally intelligent leadership that allows them to grow into a more rounded engineer.

Regarding Empathy, it was clear in both questionnaires the misconception students have about what empathy entails. Their initial responses were related to the popular saying ‘ be in somebody’s shoes’ . However, it is not as easy as it may seem, because those shoes can “ the wrong size, the wrong design, or colour” . The initial data among the target group showed that all of the respondents, according to their responses, possessed well developed empathic skills. After the intensive period activity, their responses showed that the same respondents; namely 50 % had experience instances of lack of empathy. Furthermore, the individuals who were given more responsibilities, and power within in the groups, showed less empathic behaviour, and therefore less effective social and communication skills. As a consequence the enrichment that diversity should have brought to the group diminished since there was not “real” inclusion of ideas.

As exposed in the previous paragraph the lack of empathy was an important factor that affected communication when being under pressure and out of the comfort zone. Another important factor that influenced effective communication was the multicultural nature of the group, in which communication styles, active participation and feedback reflected the cultural background of the individuals. The fact that for many group members English was their second language and used as *Lingua Franca*, was only an impediment at the beginning of their collaboration since all native speakers and non-native speakers, adapted their discourse to a common ground ‘ Engineering’ lingo.

5. CONCLUSIONS RECOMMENDATIONS

According to recently publish article by Harvard University Press (2021) Emotional intelligence is often much narrowly defined, focusing only on a person’s sociability, sensibility and likability overlooking the critical elements of EI that could make an individual an effective leader such as the ability to deliver difficult feedback, drive change and creative thinking. Strathclyde University strives in their ICP programme to develop these attributes to enhance the employability of their students. However, it appears that regarding attributes 2 and 6 more should be done to embed the development of these skills within the Civil Engineering Curriculum. Many institutions around the world have realised that EQ is as important As IQ , and have started to train these so called “soft skills” with the aid of expert coaches.

The development of empathic skills remain an ongoing process, and a key skill to enhance diversity and inclusion, as well as leadership skills. Research shows that personal power interferes with our empathic skills , the ability to read emotions and the ability to adapt behaviours. It is crucial to train empathic skills in the new generation on of engineers to be more rounded professionals, according to Rottmann, C., et al (2014) Engineers who embody a collaborative leadership orientation derive job satisfaction from extensive professional networks and high quality of project

delivery. It seems that “First the Human then the Engineer” is a principle that when applied hones sustainable leadership skills beneficial for the individual and organisations.

This is also very apparent when we look at the deliveries of the Masters Program and we see not only the participating students turning their theory into practice but developing these softer skills considerably enhancing their employability through a greater awareness of their own abilities within a team. However it is important to note that the greater learning was achieved through experiential learning where the participant is taken well out of their comfort zone and allowed to make their own collective mistakes within a safe environment unlike in a conventional work placement where they are still chaperoned and coaxed towards the intended outcome. Whilst during the intensive study the participating students were immersed fully in their project activities and were having to problem solve in real time whilst feeling the added weight of expectation being exerted upon them from the ExpLearn staff who were eliciting a perceived stress which made the whole program seem more real and come alive for them more so than a work placement or their lecturers could have delivered for them. This shows the importance of engaging with external delivery partners who can create the experiential learning platform and through this collaboration a very strong program can be developed which creates future engineers who have the transversal skills as well as the technical skills to become effective contributors and global citizens.

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